

WHAT IS CLAIMED:

Sub
Al 5 1. A method for removing an oxide material from the surface of a substrate or a coating disposed on the substrate, comprising the step of contacting the oxide material with an aqueous composition which comprises an acid having the formula H_xAF_6 , or precursors to said acid, wherein A is selected from the group consisting of Si, Ge, Ti, Zr, Al, and Ga; and x is 1-6.

2. The method of claim 1, wherein x is 1-3.

3. The method of claim 1, wherein the acid is present at a level in the range of about 0.05 M to about 5 M.

Sub DI 10 4. The method of claim 3, wherein the acid is present at a level in the range of about 0.2 M to about 3.5 M.

5. The method of claim 1, wherein the precursor is a salt of the acid.

Sub C 15 6. The method of claim 1, wherein the aqueous composition comprises the compound H_2SiF_6 , H_2ZrF_6 , or mixtures thereof.

Sub DI 7. The method of claim 6, wherein the H_2SiF_6 compound is formed in situ within the aqueous composition, by the dissociation of a corresponding salt of the compound; or by the reaction of a silicon-containing compound with a fluorine-containing compound.

20 8. The method of claim 7, wherein the silicon-containing compound is SiO_2 , and the fluorine-containing compound is HF.

9. The method of claim 1, wherein the aqueous composition further comprises at least one additional acid or precursor thereof.

10. The method of claim 9, wherein the additional acid has a pH of less than about 7 in pure water.

25 11. The method of claim 10, wherein the additional acid has a pH of less than about 3.5 in pure water.

12. The method of claim 9, wherein the additional acid is a mineral acid.

13. The method of claim 9, wherein the additional acid is selected from the group consisting of phosphoric acid, nitric acid, sulfuric acid, hydrochloric acid, hydrofluoric acid, hydrobromic acid, hydriodic acid, acetic acid, perchloric acid, phosphorous acid, phosphinic acid, alkyl sulfonic acids, and mixtures of any of the foregoing.

14. The method of claim 9, wherein the additional acid is phosphoric acid.

15. The method of claim 9, wherein the additional acid is present at a level less than about 80 mole %, based on the total moles of acid present in the aqueous composition.

16. The method of claim 15, wherein the additional acid is present at a level within in the range of about 20 mole % to about 70 mole %.

17. The method of claim 1, wherein the oxide material is treated in a bath of the aqueous composition.

18. The method of claim 17, wherein the bath is maintained at a temperature in the range of about room temperature to about 100°C, during treatment.

19. The method of claim 18, wherein the temperature is in the range of about 45°C to about 90°C.

20. The method of claim 18, wherein the treatment time is in the range of about 10 minutes to about 72 hours.

21. The method of claim 20, wherein the treatment time is in the range of about 60 minutes to about 20 hours.

22. The method of claim 17, wherein the bath further comprises at least one additive selected from the group consisting of inhibitors, dispersants, surfactants, chelating agents, wetting agents, deflocculants, stabilizers, anti-settling agents, reducing agents, and anti-foam agents.

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A2
5 23. A method for removing a coating and an oxide material from a substrate, comprising the step of exposing the substrate to an aqueous composition under conditions sufficient to remove substantially all of the oxide material and substantially all of the coating, wherein the aqueous composition comprises an acid having the formula H_xAF_6 , or precursors to said acid, wherein A is selected from the group consisting of Si, Ge, Ti, Zr, Al, and Ga; and x is 1-6.

Sub C4
10 24. A method for removing an oxide material from a diffusion- or overlay coating on the surface of a turbine engine component, comprising the step of contacting the oxide material with an aqueous composition which comprises H_2SiF_6 or H_2ZrF_6 , or mixtures thereof.

Sub D1
15 25. The method of claim 24, wherein the aqueous composition further comprises an additional acid selected from the group consisting of phosphoric acid, nitric acid, sulfuric acid, hydrochloric acid, hydrofluoric acid, and mixtures thereof, wherein the additional acid is present at a level less than about 80 mole %, based on the total moles of acid present in the aqueous composition.

26. The method of claim 24, wherein the oxide material is also initially present in at least one cavity within the turbine engine component, and is removed therefrom during treatment with the aqueous composition.

Sub C5
20 27. A method for replacing a worn or damaged protective coating applied over a substrate, comprising the following steps:

(i) removing an oxide material from the surface of a coating disposed on the substrate, by contacting the oxide material with an aqueous composition which comprises an acid having the formula H_xAF_6 , or precursors to said acid, wherein A is selected from the group consisting of Si, Ge, Ti, Zr, Al, and Ga; and x is 1-6;

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(ii) removing the coating disposed on the substrate, by contacting the coating with an aqueous composition which comprises an acid having the formula H_xAF_6 , or precursors to said acid, wherein A is selected from the group consisting of Si, Ge, Ti, Zr, Al, and Ga; and x is 1-6; and then

(iii) applying a new coating to the substrate.

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28. The method of claim 27, wherein steps (i) and (ii) are carried out simultaneously, using the same aqueous composition.

29. The method of claim 27, wherein oxide material which directly contacts the substrate is also removed in step (i).

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30. The method of claim 28, wherein the aqueous composition further comprises at least one additional acid or precursor thereof.

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31. The method of claim 30, wherein the additional acid is selected from the group consisting of phosphoric acid, nitric acid, sulfuric acid, hydrochloric acid, hydrofluoric acid, hydrobromic acid, hydriodic acid, acetic acid, perchloric acid, phosphorous acid, phosphinic acid, alkyl sulfonic acids, and mixtures of any of the foregoing.

32. The method of claim 27, wherein the coating removed in step (ii) and the coating applied in step (iii) are each selected from the group consisting of diffusion coatings and overlay coatings.

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33. The method of claim 27, wherein the new coating of step (iii) is applied by a technique selected from the group consisting of vacuum plasma spray (VPS); air plasma spray (APS); high velocity oxy-fuel (HVOF); sputtering; physical vapor deposition (PVD); electron beam physical vapor deposition (EB-PVD); and diffusion-aluminiding.

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34. The method of claim 1, wherein the substrate is a metallic material or a polymeric material.